

LATIN AMERICA: R&D SPENDING JUMPS IN BRAZIL, MEXICO, AND COSTA RICA

Summary: R&D spending by six Latin American countries combined increased markedly between 1990 and 1996. This gain in spending was split between very substantial increases in Brazil, Mexico, and Costa Rica, with declines reported by Chile, Argentina, and Venezuela. The public sector was the dominant source of funding and main performer of R&D in these countries. The United States supported R&D in these and other Latin American countries through funding of collaborative R&D, support of international financial institutions, which are providing science and technology loans to these countries, and through subsidiary companies conducting industrial R&D in Latin America.

R&D SPENDING BY SIX LATIN AMERICAN COUNTRIES COMBINED ROSE SUBSTANTIALLY IN THE 1990-1996 PERIOD

Expenditures on research and development (R&D), adjusted for inflation rose over 40 percent, increasing from \$8.7 billion in 1990 to \$12.3 billion in 1996 in six Latin American countries (figure 1). In 1996, these countries accounted for over 90 percent of the estimated \$13.7 billion of R&D spending in the Latin American and Caribbean region.¹

Brazil, Mexico, and Costa Rica increased their R&D spending substantially:

- Brazil almost doubled its R&D spending between 1990 and 1996 (figure 2), with expenditures amounting to \$7.1 billion in 1996² (figure 1), accounting for almost 60 percent of R&D expenditures by the six countries.

¹Latin America and the Caribbean include countries in South & Central America and the Caribbean region except Cuba that reported R&D spending in 1996 to Red Iberoamericana de Indicadores de Ciencia y Tecnologia (RICYT). RICYT is an organization of Inter-American countries that is developing and improving indicators of science and technology in the Inter-American region. The estimated \$1.2 billion of R&D expenditures by other countries consists of \$1.0 billion by Colombia, with the remainder by all other countries in the Latin American and Caribbean region. This NSF report excludes Cuba due to a lack of a PPP conversion rate.

²The \$7.1 billion was the PPP value; as a comparison, R&D expenditures at the market exchange rate were \$5.8 billion in 1996.

Brazil's large share of total R&D spending by these countries is due, in part, to the large size of its economy, which accounts for 40 percent of total economic output by these six countries.³

- R&D spending in Mexico rose by a similar magnitude, with expenditures increasing from \$1.1 billion to \$2.1 billion (figure 1) during this period, an increase of over 90 percent (figure 2). Mexico's 1996 expenditures accounted for 17 percent of total R&D spending, while the Mexican economy accounted for a 30 percent share of total economic output of these six countries.
- Costa Rica's R&D expenditures in 1996 were \$248 million, more than double their level in 1990 (figure 2). Its R&D expenditures accounted for 2 percent of total R&D spending by these six countries.

R&D spending, adjusted for inflation, declined in Argentina, Chile, and Venezuela:

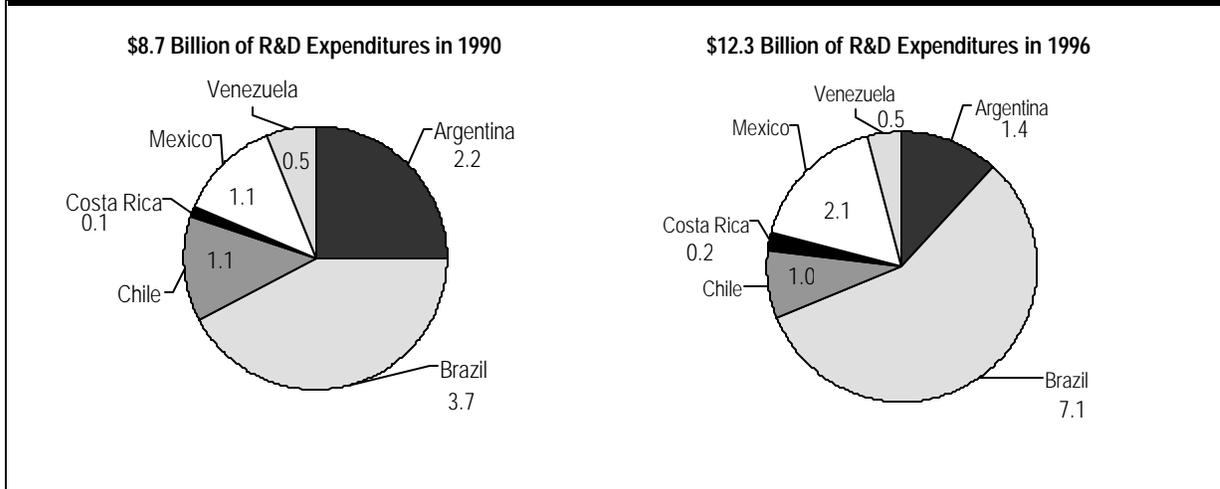
- R&D spending in Argentina fell about 35 percent (figure 2) from 1990 to \$1.4 billion in 1996 (figure 1), the largest drop in the six countries, during this period.
- Chile's R&D expenditures dropped about 10 percent (figure 2) from 1990 to \$1 billion in 1996 (figure 1).
- Venezuela's expenditures fell by about 4 percent (figure 2) from 1990 to \$519 million in 1996.

Despite strong gains by Brazil, Costa Rica, and Mexico, the share of R&D in Latin American countries lagged the levels of more developed countries:

- The ratio of R&D to GDP was less than 0.8 percent in 1996 in five of the six Latin American countries. Costa Rica was the only country in the entire Latin American region, where R&D exceeded 1 percent of GDP. While the share of R&D to GDP, particularly in Brazil and Costa Rica, was generally comparable

³As measured in 1992 constant U.S. dollars of GDP using PPP conversion rates.

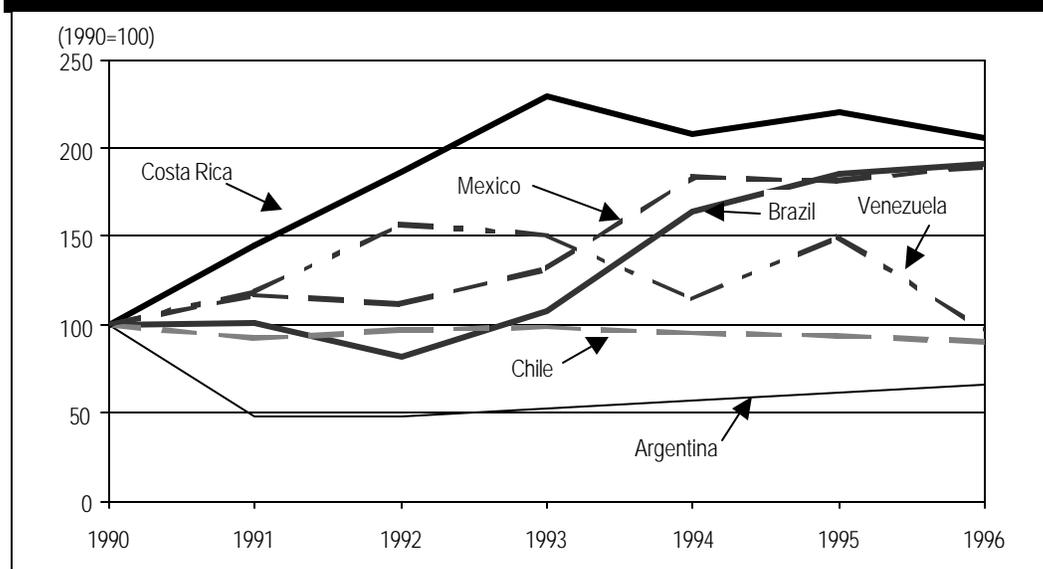
Figure 1. R&D spending by six Latin American countries



NOTES: Local currency R&D figures from RICYT were deflated into 1992 constant U.S. dollars using the World Bank's Gross Domestic Product (GDP) deflators and purchasing power parity (PPP) conversion rates. Figures should be regarded with caution given possible variations in survey and reporting methodologies by countries. Brazil R&D figures in dollars were imputed to reconcile currency reporting differences. Argentina and Venezuela figures are science and technology activities, a broader measure than R&D that includes technical training.

SOURCES: Red Iberoamericana de Indicadores de Ciencia y Tecnología (RICYT), *Principales Indicadores de Ciencia y Tecnología 1990-1997*. Buenos Aires, Argentina: RICYT, June 1999. Data in this publication are available at www.unq.edu.ar/ricyt/.
The World Bank. *World Development Indicators 1998*. Washington, DC: The World Bank, April 1998. Information and some data are available at www.worldbank.org/data/wdi/home.html.

Figure 2. Index of real R&D expenditures



NOTES: Local currency R&D figures from RICYT were deflated with the World Bank's Gross Domestic Product (GDP) country deflators and converted to 1990 index numbers. Argentina and Venezuela figures are science and technology activities, a broader measure than R&D that includes technical training.

SOURCES: Red Iberoamericana de Indicadores de Ciencia y Tecnología (RICYT), *Principales Indicadores de Ciencia y Tecnología 1990-1997*. Buenos Aires, Argentina: RICYT, June 1999. Data in this publication are available at www.unq.edu.ar/ricyt/.

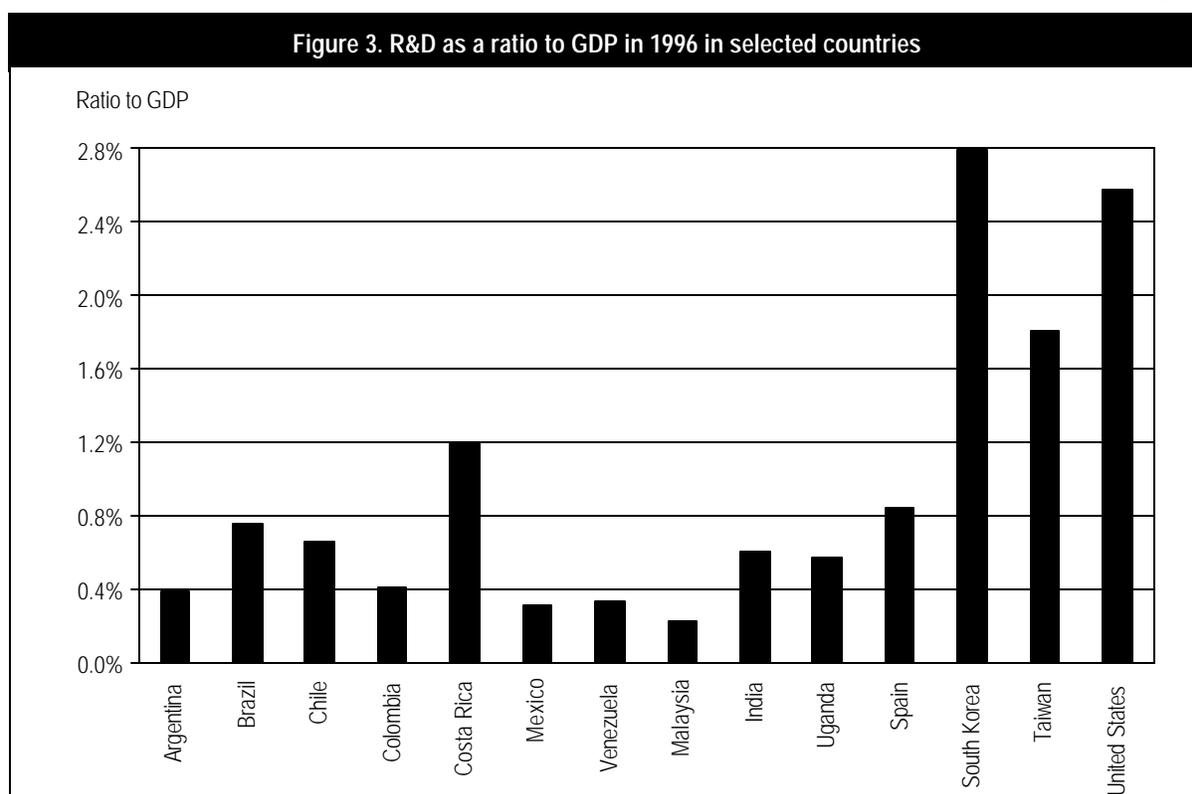
The World Bank. *World Development Indicators 1998*. Washington, DC: The World Bank, April 1998. Information and some data are available at www.worldbank.org/data/wdi/home.html.

to some developing countries, it was far below that of Asian tigers, such as Taiwan and South Korea (figure 3) or upper income countries, such as the United States.

- The paucity of industry R&D is one factor in the relatively low level of R&D in Latin America compared to industrialized countries. In most Latin American countries, public spending accounts for over 70 percent of R&D funding, compared to approximately 25 percent in some of the newly industrialized countries of Asia and less than 50 percent in most industrialized countries.⁴ The vulnerability of public spending to financial volatility and crisis may have also played a role in the low, and sometimes erratic, level of R&D spending in Latin America.

The public sector was the dominant funder of R&D in the six countries:

- Governments and universities — the traditional sources of R&D financing in Latin America — provided the bulk of R&D funding during this period (table 1). The universities that finance R&D consist predominately of large public institutions, and are conduits of additional public funding of R&D. With the exception of Venezuela, the public sector, including the university sector, accounted for two-thirds to three-quarters of R&D funding in 1996.⁵
- The public sector's share may be understated because the industrial sector includes publicly owned firms.⁶ This appears to be the case in Brazil, where public firms provided one third of industrial funding in 1995.



NOTES: All figures are the ratio of R&D to Gross Domestic Product (GDP), except Argentina and Venezuela figures are science and technology activities, a broader measure than R&D that includes technical training.

SOURCES: RICYT - Argentina, Brazil, Chile, Colombia, Costa Rica, Mexico, Venezuela; NSF - India, South Korea, Taiwan, and the United States; UNESCO - Uganda

⁵Mexico data are for 1995.

⁶The reporting of industry R&D in RICYT is consistent with the OECD's guidelines (OECD 1993 *Frascati Manual*, p. 50), which includes public enterprises engaged in market activities. In addition, public enterprises have historically been the only source of industry R&D in Latin America prior to privatization and market reforms carried out in many countries in the late 1980's and early 1990's.

⁴Inter-American Development Bank, "Science and Technology for Development: A Strategy Paper", October 1999, p. I.

If industry R&D financing by public firms were counted as part of the public sector, the public sector's share in Brazil would be an estimated 73 percent in 1996, compared to the official figure of 60 percent, which excludes financing by public firms.⁷

Table 1. Financing sources of R&D in 1996 in percentage share

| Country | Government | University | Industry | Nonprofit | Foreign | Total |
|----------------|------------|------------|----------|-----------|---------|-------|
| Argentina..... | 46.3 | 20.3 | 28.0 | 1.7 | 3.7 | 100.0 |
| Brazil..... | 57.2 | 2.8 | 40.1 | NA | NA | 100.0 |
| Chile..... | 69.5 | 7.5 | 16.6 | NA | 6.4 | 100.0 |
| Costa Rica.... | 53.4 | 14.8 | 17.4 | 4.5 | 9.9 | 100.0 |
| Mexico..... | 66.2 | 8.4 | 17.6 | 1.1 | 6.7 | 100.0 |
| Venezuela.... | 32.0 | 23.4 | 44.6 | NA | NA | 100.0 |

KEY: NA = Not available.

NOTES: Argentina and Venezuela figures are science and technical activities, a broader measure than R&D that includes technical training. Mexico is 1995 data. Components may not add to total due to rounding discrepancies.

SOURCES: Red Iberoamericana de Indicadores de Ciencia y Tecnología (RICYT), *Principales Indicadores de Ciencia y Tecnología 1990-1997*. Buenos Aires, Argentina: RICYT, June 1999. Data in this publication are available at www.unq.edu.ar/ricyt/.

Other funders of R&D included nonprofits and international organizations, notably the World Bank and Inter-American Development Bank (IDB):

- Nonprofit organizations and foreign financing by foundations and international organizations, provided small but significant levels of funding (5 to 15 percent) for R&D in Argentina, Chile, Costa Rica, and Mexico. In particular, the World Bank and Inter-American Development Bank (IDB) provided substantial resources to support science and technology activities in the region. For example, the World Bank and IDB recently approved almost \$600 million in multi-year science and technology loans for Argentina, Brazil, and Mexico. Counterpart financing

⁷Data on funding by private industry provided by CNPq (National Council for Research), a Brazilian governmental agency, as part of a November 1999 presentation to the National Science Board on "R&D Budget Coordination and Priority Setting." Public and private industry accounted for 40 percent of total R&D funding in 1996. The one-third share of public industry to total industry funding in 1995, if applied to the 1996 financing figures, would amount to an estimated 13 percent share of public industry funding of total R&D during 1996, effectively increasing the public sector's share from 60 to 73 percent.

by the governments and private industry will provide an additional \$700 million, for a total of \$1.3 billion in resources for these countries.⁸

In addition to being the primary funder, the public sector was the dominant performer of R&D in four countries:⁹

- The public sector in 1996 conducted more than half of R&D in Argentina, Brazil, Chile, and Mexico through government agencies and public universities.¹⁰ Chile's government performs roughly half of that country's R&D, and the Argentine and Mexican public sectors conduct a third or more of their national R&D (table 2). Brazil is an outlier, with government performing a much smaller share of national R&D, accounting for only about 11 percent.
- Latin America's system of large public universities has traditionally carried out a substantial share of R&D. The share ranged from 30 to 45 percent in Argentina, Brazil, Chile, and Mexico in 1996.¹¹ As in the case of R&D funding, the public's share of R&D performance may be understated because industry's share includes R&D performed by public enterprises.

Industry R&D has increased its share of total R&D performed in four countries:

- The industrial (public and private) sector of all four countries, particularly Brazil and Mexico, increased its share of total R&D during this period. For example, Brazil's share rose from 24 percent in 1990 to 46 percent in 1996 and Mexico's share increased from 10 percent in 1993 to 21 percent in 1995. The private sector in Mexico performed the bulk of industrial R&D, with its share rising from 75 percent in 1994 to 90 percent of total industry R&D in 1995.
- The extent of participation by the private sector in other countries is unclear due to lack of data on private industrial R&D performance. In the case of Brazil,

⁸Information on the IDB's activities is available at <http://www.iadb.org/exr/PRENSA/prstec.htm>. Information on World Bank loans is available at <http://wbln0018.worldbank.org/external/lac/lac.nsf>. See also "World Bank renews its support for Brazil," *Nature*, February 5, 1998, p. 317.

⁹Data are unavailable for Costa Rica and Venezuela.

¹⁰Mexico data are for 1995.

¹¹Mexico data are for 1995.

however, large-scale privatization, the introduction of R&D tax credits for private industry, and the strengthening of patenting law during the 1990-96 period would be consistent with private industry driving the increased share of industrial R&D in that country.

Table 2. Performers of R&D in 1996 in percentage share

| Country | Government | University | Industry | Nonprofit | Total |
|----------------|------------|------------|----------|-----------|-------|
| Argentina..... | 41.0 | 31.5 | 25.9 | 1.7 | 100.0 |
| Brazil..... | 11.0 | 43.5 | 45.5 | NA | 100.0 |
| Chile..... | 50.6 | 45.6 | 2.8 | 0.9 | 100.0 |
| Mexico..... | 33.0 | 45.8 | 20.8 | 0.4 | 100.0 |

KEY: NA = Not available.

NOTES: Argentina figures are science and technology activities, a broader measure than R&D that includes technical training. Mexico is 1995 data. Components do not necessarily sum to total due to rounding discrepancies.

SOURCES: Red Iberoamericana de Indicadores de Ciencia y Tecnología (RICYT), *Principales Indicadores de Ciencia y Tecnología 1990-1997*. Buenos Aires, Argentina: RICYT, June 1999. Data in this publication are available at www.unq.edu.ar/ricyt/.

The U.S. has been playing an active role in supporting R&D in the Latin American region in several ways:

- The U.S. private sector was an active performer of industry R&D in these six countries (table 3). R&D expenditures by U.S. affiliates in these countries rose from \$195 million in 1990 to \$666 million in 1996, a more than threefold increase. The largest recipient was Brazil, followed by Mexico and Argentina. These six countries accounted for 97 percent of R&D performed in 1996 by U.S. subsidiaries in the entire region.¹² This substantial increase is consistent with the general trend of increased globalization of U.S. R&D and efforts by many Latin American countries to open up their economies to foreign trade and investment.

¹²Source: U.S. Bureau of Economic Analysis, *U.S. Direct Investment Abroad*. Washington, DC: U.S. Bureau of Economic Analysis, 1998.

Table 3. R&D performed by U.S. affiliated companies

| Country | 1990 | 1996 |
|------------------------|--------------------------|------|
| | (In millions of dollars) | |
| Six-country total..... | 195 | 666 |
| Brazil..... | 113 | 489 |
| Mexico..... | 53 | 119 |
| Argentina..... | 14 | 42 |
| Venezuela..... | 11 | 8 |
| Chile..... | 3 | 6 |
| Costa Rica..... | 1 | 2 |

NOTE: Figures are unadjusted for inflation. Countries are ranked by level of R&D in 1996.

SOURCE: U.S. Bureau of Economic Analysis, *U.S. Direct Investment Abroad*. Washington, D.C., U.S. Bureau of Economic Analysis, 1998.

- The U.S. Government supported international cooperative R&D activities, where a U.S.-funded researcher was involved in a project with a foreign or multinational partner. In fiscal year 1995 (Oct. 1994-Sept. 1995), the United States provided an estimated \$44 million in bilateral funding to Latin America. This was approximately 9 percent of the \$497 million in total funding provided for collaborative R&D on a bilateral basis. This amount does not include funding for multinational activities that may include Latin American countries or other scientific and technological activities, such as conferences.¹³
- As the largest shareholder among member countries in the World Bank and IDB,¹⁴ the United States has been instrumental in approving and helping to finance loans for science and technology in the region, such as the \$600 million recently approved by these organizations for Argentina, Brazil, and Mexico.

¹³Wagner, Caroline, *International Cooperation in Research and Development*. Santa Monica, CA: RAND, 1997.

¹⁴The U.S. has the largest share of paid-in capital of member countries in the World Bank and IDB. See <http://www.worldbank.org/html/extpb/annrep/pdf/ibrd.pdf> for shares of member countries in the World Bank. See <http://www.iadb.org/fin/info0699.pdf> for shares of member countries in the IDB.